



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

# FLORE

## Repository istituzionale dell'Università degli Studi di Firenze

### Teaching geomatics

Questa è la Versione finale referata (Post print/Accepted manuscript) della seguente pubblicazione:

*Original Citation:*

Teaching geomatics / G. Tucci; V. Bonora. - In: THE INTERNATIONAL ARCHIVES OF THE PHOTOGRAMMETRY, REMOTE SENSING AND SPATIAL INFORMATION SCIENCES. - ISSN 1682-1777. - ELETTRONICO. - (2009), pp. 1-6. (Intervento presentato al convegno XXII CIPA International Symposium "Digital Documentation, Interpretation & Presentation of Cultural Heritage" tenutosi a Kyoto nel 11-15 ottobre 2009).

*Availability:*

This version is available at: 2158/373419 since:

*Publisher:*

Yutaka Takase

*Terms of use:*

Open Access

La pubblicazione è resa disponibile sotto le norme e i termini della licenza di deposito, secondo quanto stabilito dalla Policy per l'accesso aperto dell'Università degli Studi di Firenze (<https://www.sba.unifi.it/upload/policy-oa-2016-1.pdf>)

*Publisher copyright claim:*

(Article begins on next page)

# TEACHING GEOMATICS

G. Tucci \*, V. Bonora

University of Florence, Dept. of Restoration and Conservation of Architectural Heritage, 50121 Florence, Italy  
grazia.tucci@unifi.it valentina.bonora@archimetro.it

**KEY WORDS:** Teaching, Education, Orthorectification, Knowledge Base, Laser scanning, Photogrammetry

## ABSTRACT:

In the study programmes offered by the Italian Architecture Faculties there is often little time dedicated to the teaching of Geomatics. On the other hand there is an ever-increasing awareness that the correct management of the cultural heritage requires that the importance of reliable graphic documentation be recognized; such documentation can be used for elaborating further analyses and for designing conservation projects.

This paper presents the results of practical work carried out during the Topography/Surveying and surveying methodology/Survey automation course held in the 2005-2006 academic year at the Faculty of Architecture of the Turin Polytechnic. This work consisted in the metrical survey of the facades of the Valentino Castle at Turin. The castle therefore, not only hosted the classrooms where theoretical lessons were held but also provided the material for practical experience.

## 1. GEOMATICS AND ARCHITECTURE

“Geomatics” is the term used to define all the activities linked to acquisition, processing, analysis, modelling, visualization and management of metric data, which are part of the study and research process carried out in the fields of remote sensing, cartography, GIS and survey. The training of students in architecture should focus mainly on survey, which is generally carried out on large and very large scales, allowing the analysis of urban spaces, historical buildings and architectural detail.

In the study programmes offered by the Italian Architecture Faculties there is often little time dedicated to the teaching of Geomatics. On the other hand there is an ever-increasing awareness that the correct management of the cultural heritage requires that the importance of reliable graphic documentation be recognized; such documentation can be used for elaborating further analyses and for designing conservation projects.

Architecture faculties are a privileged context for multidisciplinary contamination that is generated by research projects involving teams whose members are trained in different disciplines: historians, restorers, designers, technologists and surveyors. Participation in combined research projects often provides occasions for applying Geomatics to areas that are much smaller than those for which the discipline was first created whilst maintaining methodological and scientific rigour; methods and procedures are optimised as a consequence. The transposition of these experiences to the teaching field requires that the level of detail is matched to the training and specialized knowledge of the students involved: basic training for first-year students, specialised studies for those preparing their theses.

Basic courses, fundamental first and second year subjects, teach the skills required for undertaking a “basic survey”; this

survey describes the object being analysed and can be used to represent different themes as required. The theoretical content of the discipline is tested, albeit with the limitations of time and the large numbers of students involved, by groups of students who undertake activities similar to those in a laboratory: these range from the organizational framework to detailed surveys and graphic restitution. A phase of “on site” experience is associated with learning the procedures for measuring and elaborating the information acquired. Having to directly deal with the specific problems thrown up by a real case study makes it possible to test the application of a work method and emphasises the fact that the solution does not lie in predefined procedures. Many of the students acquire a level of operational autonomy, which, together with the theoretical notions required for correctly planning a survey, allow them to take on similar projects in the Restoration Workshops they attend in the final years of their course.

This paper presents the results of practical work carried out during the Topography/Surveying and surveying methodology/Survey automation course held in the 2005-2006 academic year at the Faculty of Architecture of the Turin Polytechnic. This work consisted in the metrical survey of the facades of the Valentino Castle at Turin. The castle therefore, not only hosted the classrooms where theoretical lessons were held but also provided the material for practical experience.

Some theses provided an in-depth investigation of certain aspects of the documentation pertaining to Valentino Castle:

- The paving of the main court, with the realisation of an orthophoto;
- A survey of the Sala del Negozio and of the Sala della Caccia, in the apartments on the piano nobile, with photogrammetric and three-dimensional scanning systems.

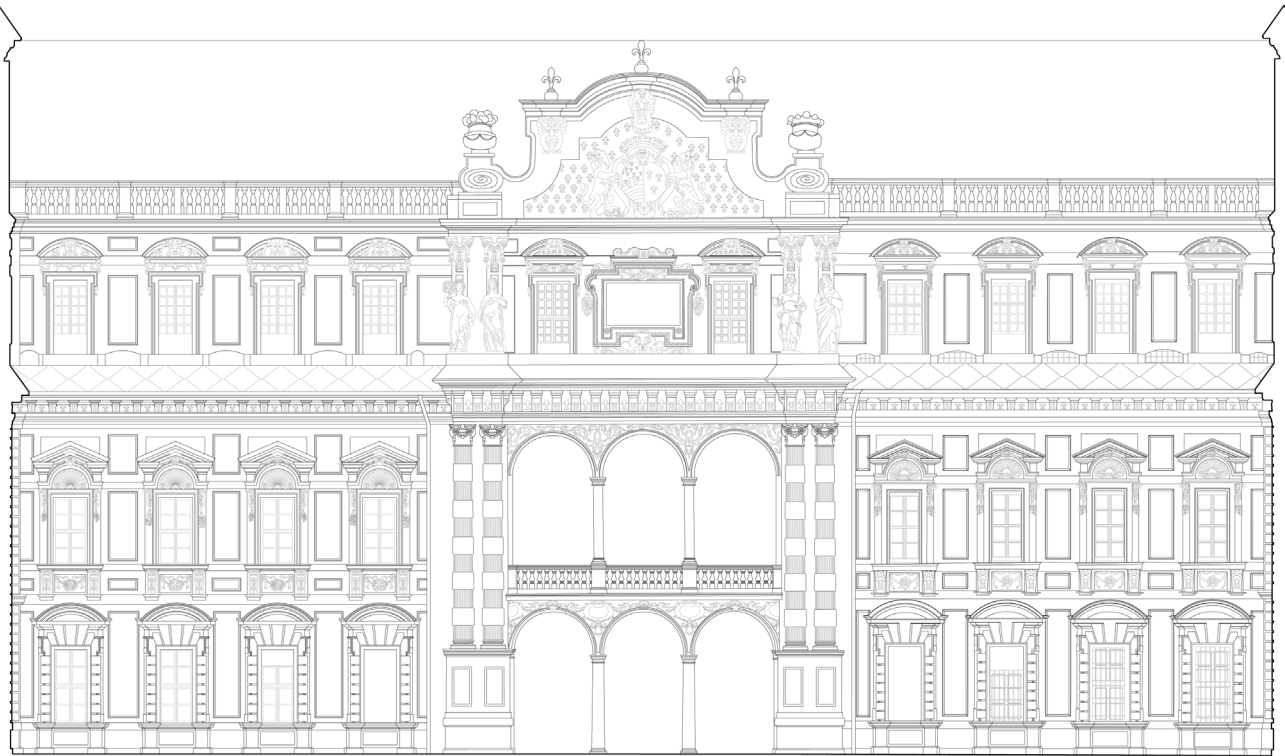


Figure 1. Elevation of Valentino Castle – synthesis (original in scale 1:100) of the drawings prepared by students (original in scale 1:50) in the Topography/Surveying and Surveying methodology and Informatics (Survey Automation courses) course, prof. G. Tucci (student's tutor V. Bonora), 2006-2007 academic year

## 2. THE “CASTELLO DEL VALENTINO”

When Emmanuel Philibert moved the capital of the Duchy of Savoy from Chambéry to Turin, in the second half of the sixteenth century, he launched a series of great projects, including the one that would have transformed the Castello del Valentino (Valentino Castle) from a simple country villa into a sumptuous palace. The major changes undergone by the building were carried out in several stages: the most remarkable were those promoted by Christine Marie of France, started in 1630, who entrusted Mr. Carlo di Castellamonte, an architect, and his son Amedeo, with huge extension works. Even though the Castle surrounded by the Valentino Park has never been completed, it is a mixture of the Italian architecture and the French “pavillon-système” and steep slate roofs.

New changes were carried out in the nineteenth century: the façade overlooking the river Po, originally the main entrance of the palace, became the secondary one, in favour of the opposite one overlooking the city. Two two-storey exhibition galleries were built to replace the pre-existing lower halls along the main court (Cortile d'onore). Their windows recall the seventeenth-century decoration patterns. The façade of the main body overlooking the city and the façades of the long side wings are the subject of the exercise proposed to the students during the a.y. 2005-2006, while the metric documents of the pavement of the main court (Cortile d'onore) are the subject of a first-level degree thesis.

In the main body of the building there are rooms through which it is possible to reach the main floor, split into two by the Central Hall (Salone d'Onore): the apartments of Christine Marie of France, also known as Madama Reale, are located in the southern part, while the apartments of his son Charles Emmanuel II are located in the northern part. The interior was decorated by two master plasterers of Lugano (Isidoro Bianchi and his sons Pompeo and Francesco). The rooms on the main floor are

decorated with volutes, floral motifs, rosettes and putti, while the vaults are covered with allegorical, mythological and historical frescoes. The survey of the two rooms on the main floor carried out using 3D scanning systems and photogrammetric techniques was discussed thoroughly in some first-level degree theses.

At the beginning of the nineteenth century, after a long period of decay, the Castello del Valentino (Valentino Castle) was involved in high civil and military training activities: from 1801 to 1804 it housed the School of Veterinary Medicine, in 1824 it underwent restoration interventions to accommodate the barracks of Genio Pontieri (Military Engineer) and finally in 1861 it became the seat of the Regia Scuola di Applicazione per gli Ingegneri (Royal School for Engineers).

The Polytechnic University of Turin was founded in 1906, as a result of the union between the Regia Scuola (Royal School) and the Regio Museo Industriale (Royal Industrial Museum). Since the birth of these academic institutions, the castle has been housing the Faculty of Engineering and Architecture: the former, along with its central offices, was moved to a new building in 1958; while the courses of the latter are still taking place mainly in the classrooms located in the long wings of the Castle.

## 3. DIDACTICAL EXPERIENCES AT THE CASTELLO DEL VALENTINO

### 3.1 The survey of the facades

In the a.y. 2005-2006 about 60 students actively participated in the following courses: Topography/Survey and Survey Methods/ Survey Automation (prof. Grazia Tucci, tutor Valentina Bonora). The course was divided into the three above-mentioned modules; it lasted 135 hours, including lectures and guided exercises. The first part of the course dealt with the basic elements of topography, plus some hints of photogrammetry; some lessons dealing with

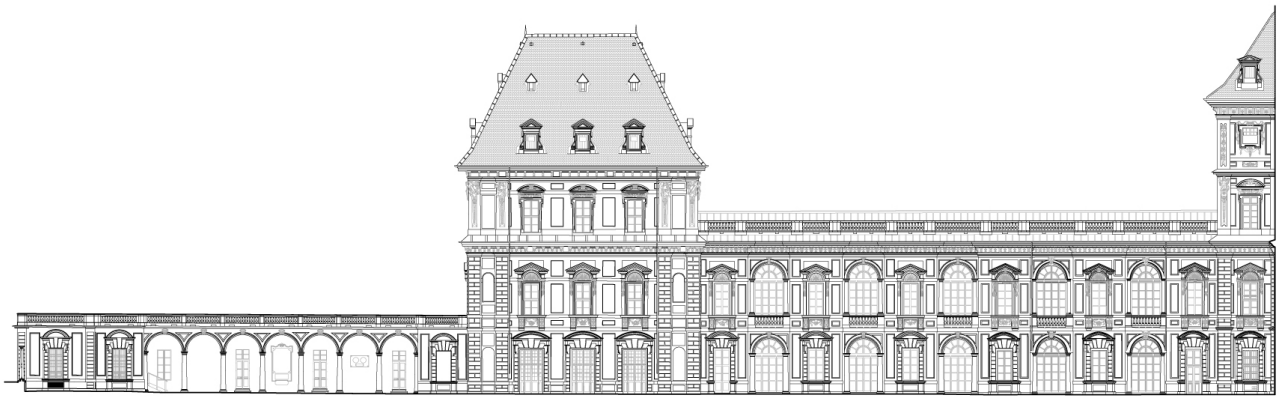


Figure 2. Elevation of Valentino Castle – synthesis (original in scale 1:100) of the drawings prepared by students (original in scale 1:50) in the Topography/Surveying and Surveying methodology and Informatics (Survey Automation courses) course, prof. G. Tucci (student's tutor V. Bonora), 2006-2007 academic year

architectural survey methods also occurred. The course included new technologies as well, both in terms of software and advanced electronic instruments: they were used during lessons - through the projection of multimedia materials; during practical exercises – for both data acquisition and graphics and numeric processing, and lastly to communicate and update information between teachers and students, a stage carried out through a dedicated web site.

For the final practical exercise of the course, students were divided into working groups; a different subject was assigned to each of them, even though the level of difficulty was quite homogeneous. For this reason, we decided to divide into equal portions all the façades of the castle, the ones overlooking the main court (Cortile d'onore). We asked each group to produce useful drawings to describe thoroughly the analysed architecture: views, profile sections and architectural details. The graphic representation was based on several detailed topographic measurements, obtained starting from the vertices of a topographic net.

### 3.2 The orthophoto of the main courtyard

The main court (Cortile d'onore) of the Castle is about 50 m x more than 100 m. The pavement is composed of white and black pebbles forming geometric patterns, and it is divided into three main sectors: towards the main body of the palace there is an area with diagonal panels, with a star in its centre; in the central part there are compressed rhombi; towards the entrance gate there is a big circle with a star, enclosed by curves defining wide and regular campitures. In the main court (Cortile d'onore), from the altimetric point of view - despite an apparently regular and uniform outline - there is a difference in height of about one metre and a half from the entrance gate to the palace threshold, on the opposite side. Moreover, a wrong use of the court, which has long been utilised as a parking lot, worsened the deformation of the pavement, under which a torrent merges into the river Po just near the Castle.

As a simple rectified image would not be suitable to produce correct metric documents, we took a 1:200 scale orthophoto. This activity was the subject of a first-level degree thesis, written by Ciro De Michele (supervisor Valentina Bonora). The description of the floor morphology was made using a topographic DEM, starting from the vertices of the topographic polygonal already

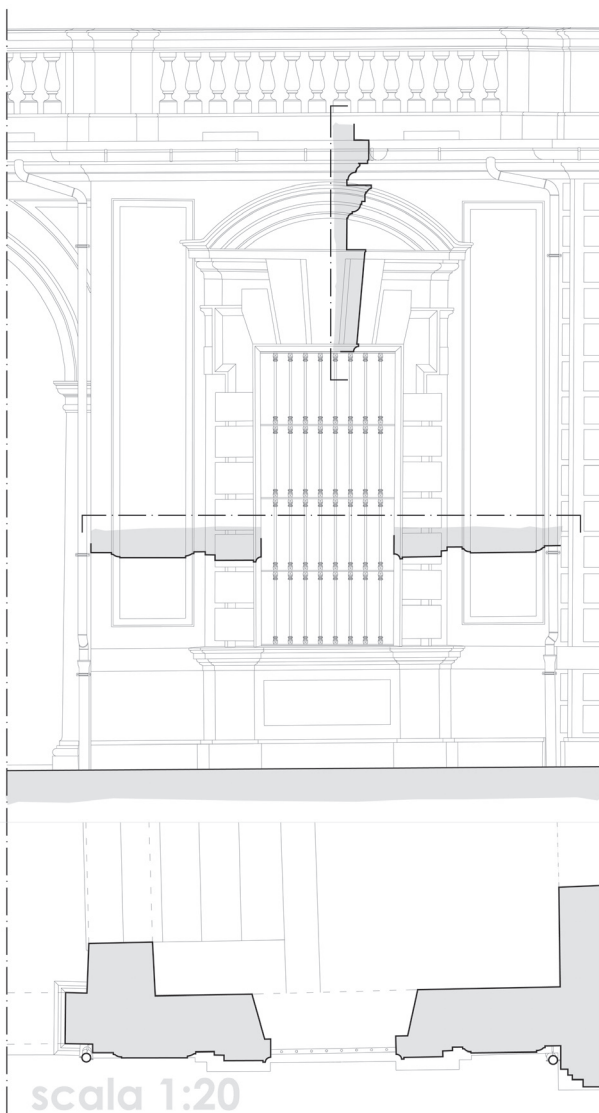


Figure 3. Detailed design of a window

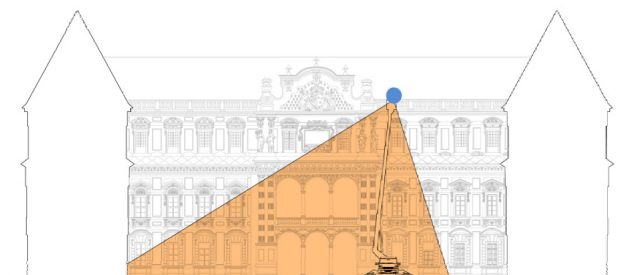


Figure 4. The photographs were taken by a drum hoist, from the height of about 20 m



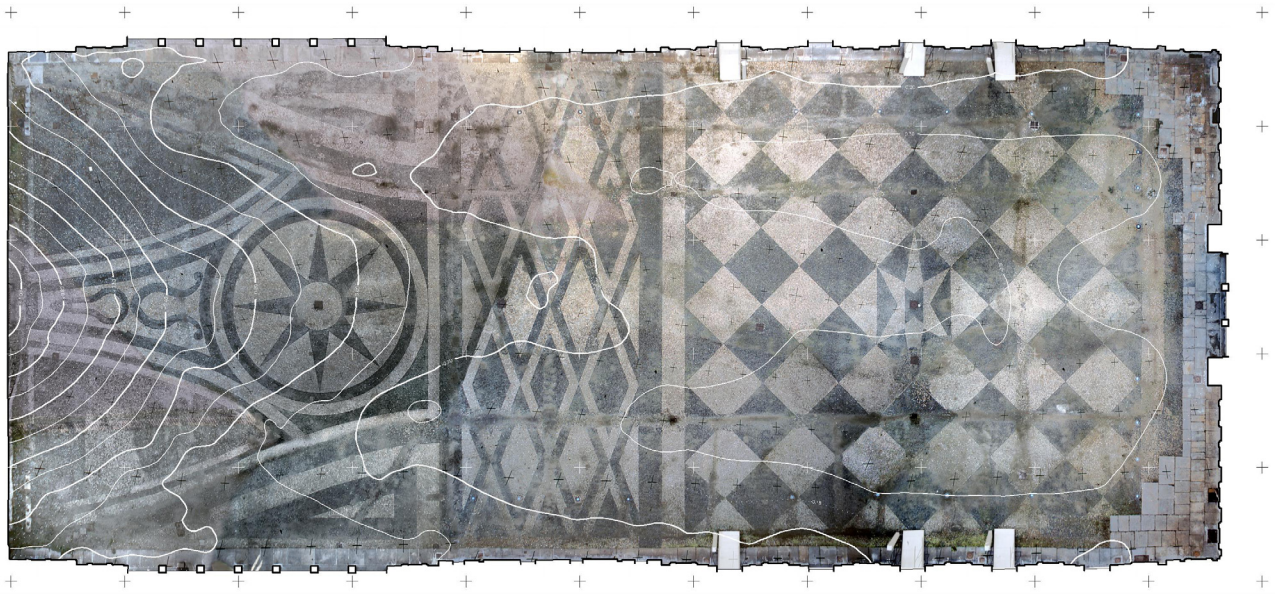


Figure 5. Digital orthophoto of the paving in the main court of Valentino Castle (original in 1:200 scale) – *Ciro De Michele* 1st level thesis, supervisor V. Bonora, 2006-2007 academic year

obtained for the practical exercise described above. Frames were shot with a semi-metric analogical camera (Rollei 6006) and then scanned. The photogrammetric project was set in the Z-Map software (Menci Software), where the inner and outer orientation of the frames was calculated; then, they were individually ortoprojected. After having cut and put all the frames together, the orthophoto was integrated with the horizontal profile of the walls surrounding the main court (Cortile d'onore).

### 3.3 The 3D survey of the rooms in the main floor

In the prince's apartments, room decoration is strictly linked to the military exploits of the reigning family. In particular, we studied the "Sala della Caccia" (Hunt room) and the "Sala del Negozio" (Shop room). In the former, Recchi's frescoes depict wild beasts and animals: Diana is surrounded by the Nymphs after a hunting party, while in the latter frescoes probably depict episodes referring to the alliance between the Savoy family and other monarchs of the time; in the middle of the vault, a fresco depicts the Peace.

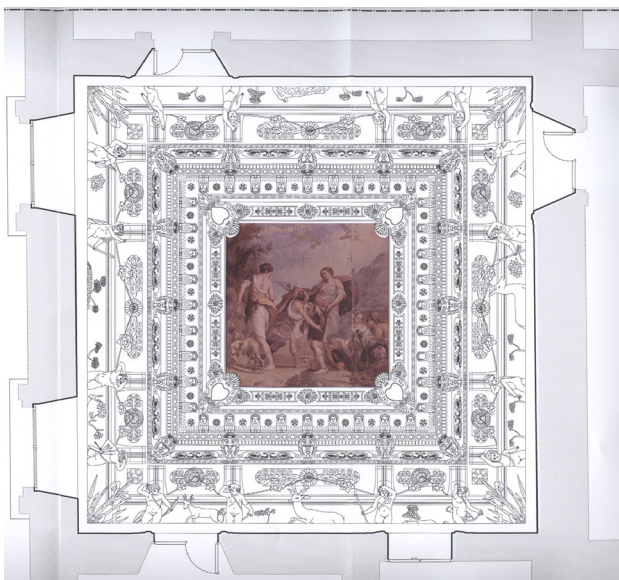


Figure 6. Sala della Caccia: plan of the vault (original in scale 1:50)

In both rooms, the fresco cycles are part of a rich decoration system made up of stuccos, and showing frames, putti and other anthropomorphic and phytomorphic figures.

The complex shape of the rooms studied forced us to carry out the survey by integrating several survey techniques: topography, photogrammetry and 3D scanning systems.



Figure 7. Internal view of the Sala del Negozio



Figure 8. Internal view of the Sala della Caccia



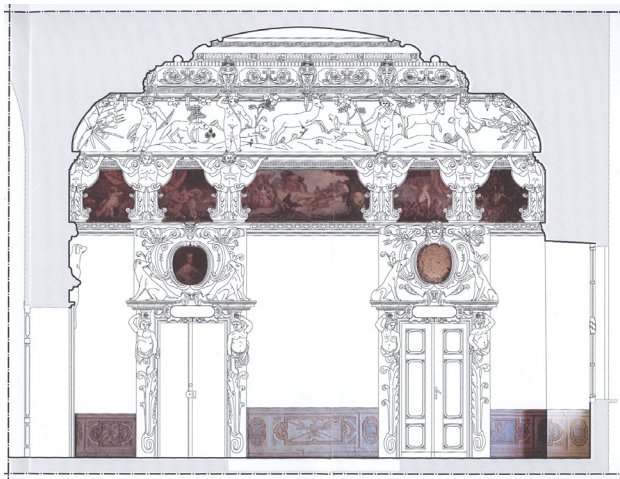


Figure 9. Sala della Caccia, vertical section  
(original in scale 1:50)

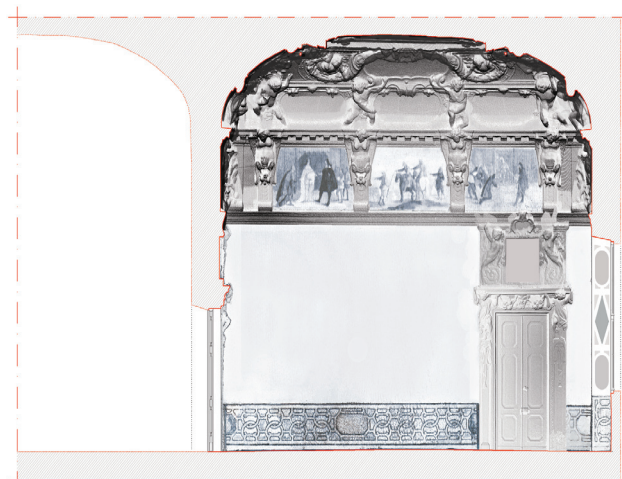


Figure 10. Sala del Negozio, vertical section  
(original in scale 1:50)

The results obtained were presented in the first-level degree theses of Giuseppe Contrafatto (Sala della Caccia, supervisor Valentina Bonora) and Nadia Guardini (Sala del Negozio, supervisor Valentina Bonora).

In both cases, the data provided by the topographic survey were essential to align and reference the 3D scanning. The following processing was diversified in order to produce plants and views-sections with different graphic content:

- in the “Sala della Caccia” we performed mainly vectorial graphic representations of the frescoed panels, integrated with the perspectively correct images;
- in the “Sala del Negozio” we chose mainly to evaluate the potential of “raster” representations, which were integrated with information coming from photos (orthophotos) and information coming from the data concerning the intensity of the reflected signal during scanning. (false-colour greyscale images).

### The ortophoto of the vault of the Sala del Negozio

The frames were shot in two strips of 5 frames each - covering stereoscopically the entire vault - with a semi-metric analogical camera (Rollei 6006) and then digitised. After the inner orientation process, we calculated the outer orientation by using bundle adjustment. We utilised as control points a series of natural features measured topographically and accurately monographed. Then we carried out the orthoreprojection on the DEM obtained through 3D scanning. The mosaicing process of the ortophotos obtained was supplemented with a vectorialization of a profile section identified just above the vault cornice.

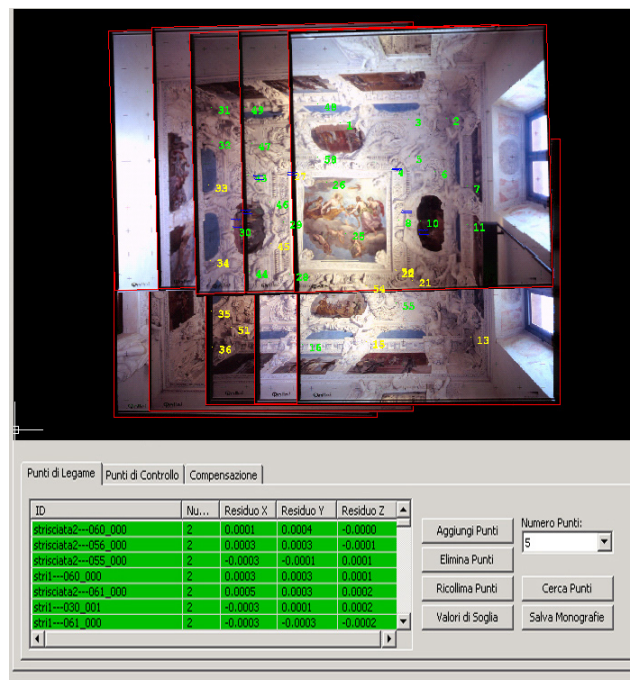


Figure 11. Outer orientation by bundle block adjustment

Figure 12. The photogrammetric block of 6 x 6 photograms of the vault







Figure 13. Sala del Negozio: orthophoto of the vault (original in scale 1:50)

#### References

Astori, B., Bonora, V., Chiabrando, F., Spanò, N., 2003. Rilevamento e rappresentazione tra ricerca ed esperienze didattiche, Atti del XXV Convegno Internazionale UID, Lercici 2003

Bonora, V., Spanò A., 2004. Strutture voltate: rilievo laser scanning e modellazione delle geometrie, Atti del Workshop "e-Arcom -Tecnologie per comunicare l'architettura", Ancona, 20-22 maggio 2004, ISBN 88-87965-17-X

Contrafatto, G., 2007. Il rilievo, con scansioni 3D della Sala della Caccia al Castello del Valentino, 1st level thesis in Architecture, Polytechnic of Turin.

Guardini, N., 2007. Rilievo metrico tridimensionale della Sala del Negozio al Castello del Valentino, 1st level thesis in Architecture, Polytechnic of Turin.

Roggero, C., Scotti, A., 1994. Il Castello del Valentino, Politecnico di Torino.

Roggero, C. (editor), 2008. Il Castello del Valentino, Allemandi, ISBN 9788842215943.

Tucci, G., Bonora, V., Spanò, N., 2003. Integrated survey methods to obtain interpretative models aimed at cultural heritage conservation, Atti del XIXth CIPA Symposium, Antalya, Turkey, 30 settembre-4 ottobre 2003, ISSN 0256-1840